国家电网
STATE GRID

Construction Modes for Remote Microgrids

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CHINA ELECTRIC POWER RESEARCH INSTITUTE

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国家电网 STATE GRID

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1.Background

- Till the end of 2012, 2.73 million people in China, mainly in remote areas and some coastal island, have no access to electric power.
- In August, 2012, National Development and Reform Commission issued the 1*2th Five-year Plan for National Rural Economic Development*, which clearly required that non-electricity rural area should be supplied with electricity during the 12th Five-year Plan.
- On July 30th, 2013, the National Energy Administration had a job meeting in Beijing. The meeting mainly discussed about solving the power supply problem in non-electricity power region, which aimed to carry out the 3-year Action Plan for Comprehensively Solving the Power Supply Problem.

Content

Typical construction mode

1. Classification of construction mode

- Abundant solar resources, wind resources and hydroelectric resources could be used to resolve power supply problem in remote area.
- Construction mode be classified in power supply area:
  - Town mode
  - village mode



2.Village mode

- Electrical load in village includes residents household consumption, utility consumption(government office, temple), agriculture product processing.
- The level of economy developing, population density and village scale are different in different villages.
- Village mode could be classified into : large scale, medium scale, small scale.



2.Village mode

Take a medium scale village as example:

- Basic information of village

80 households, about 300 people. Number of households and population is small. People live scattered.

- Load forecast

By 0.4kW per household and 5kW utility load, the total load of this is about 37kW. Considering the extreme load situation and electrical load developing scale, the load is 45kW in planning solution.

2.Village mode

- Micro-grid primary system solution

➢ Generation system
- PV+wind+storage
- PV+storage

➢ Storage
- lead-acid battery

➢ Distribution system
- Three phase- four wire system
- Distribution switch: manual/auto integrated
- Line structure：radial network
- Line type：overhead line

➢ reactive power compensation
- Reactive power compensation is not must.

2.Villege mode

- Micro-grid secondary system solution

➢ Generation metering

- Install metering mechanism at PCC.
- Metering mechanism level should higher than class 3.

➢ Household metering

- metering box: centralized/dispersed fixed up,
- handheld meter reading, wireless meter reading, power line carrier

➢ Power quality monitoring

- Install power quality monitoring mechanism at PCC.

➢ Protection

- Overcurrent protection, leakage current protection.

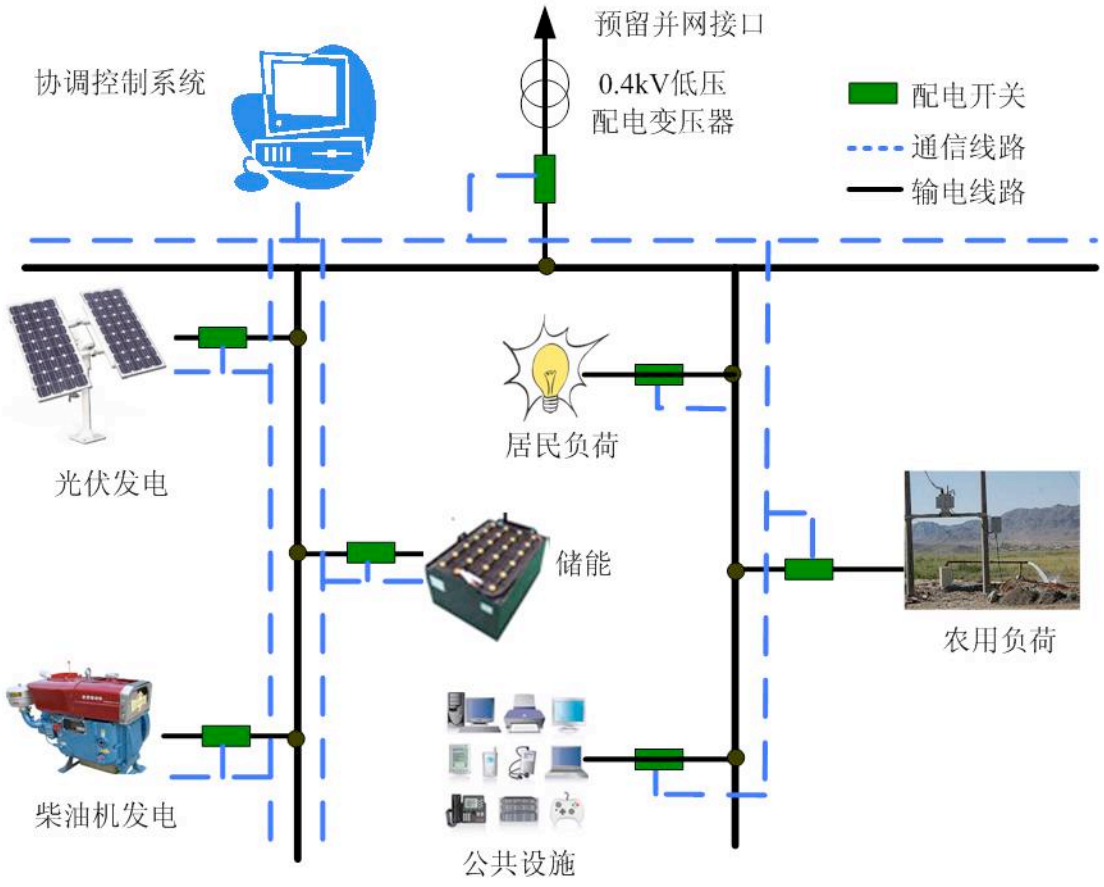
➢ Coordination control and monitoring on site

- keep system operating automatically in unattended operation
- Remote data transmission

Typical construction mode

2.Village mode

- PV generation 30kWp
- Storage 50kW/460kWh
- Diesel generator 50KW



Solar-storage micro-grid

3. Town mode

- Electrical load in town includes residents household consumption, utility consumption(government office, temple, school, hospital, road lamps), agriculture product processing consumption, commercial users(shop, restaurant, hotel).
- The level of economy developing, population density and scale are different in different town.
- Town mode could be classified into : large scale, medium scale, small scale.


3.Town mode

Take a large scale town as example

- Basic information

350 households, about 1000 people. Number of households and population is larger in town than in village. People live centralized.

- Load forecast

By 0.5kW per household and 20kW utility load, the total load of this is about 195kW. Considering the extreme load situation and electrical load developing scale, the load is 215kW in planning solution.

3.Town mode

- Micro-grid primary system solution

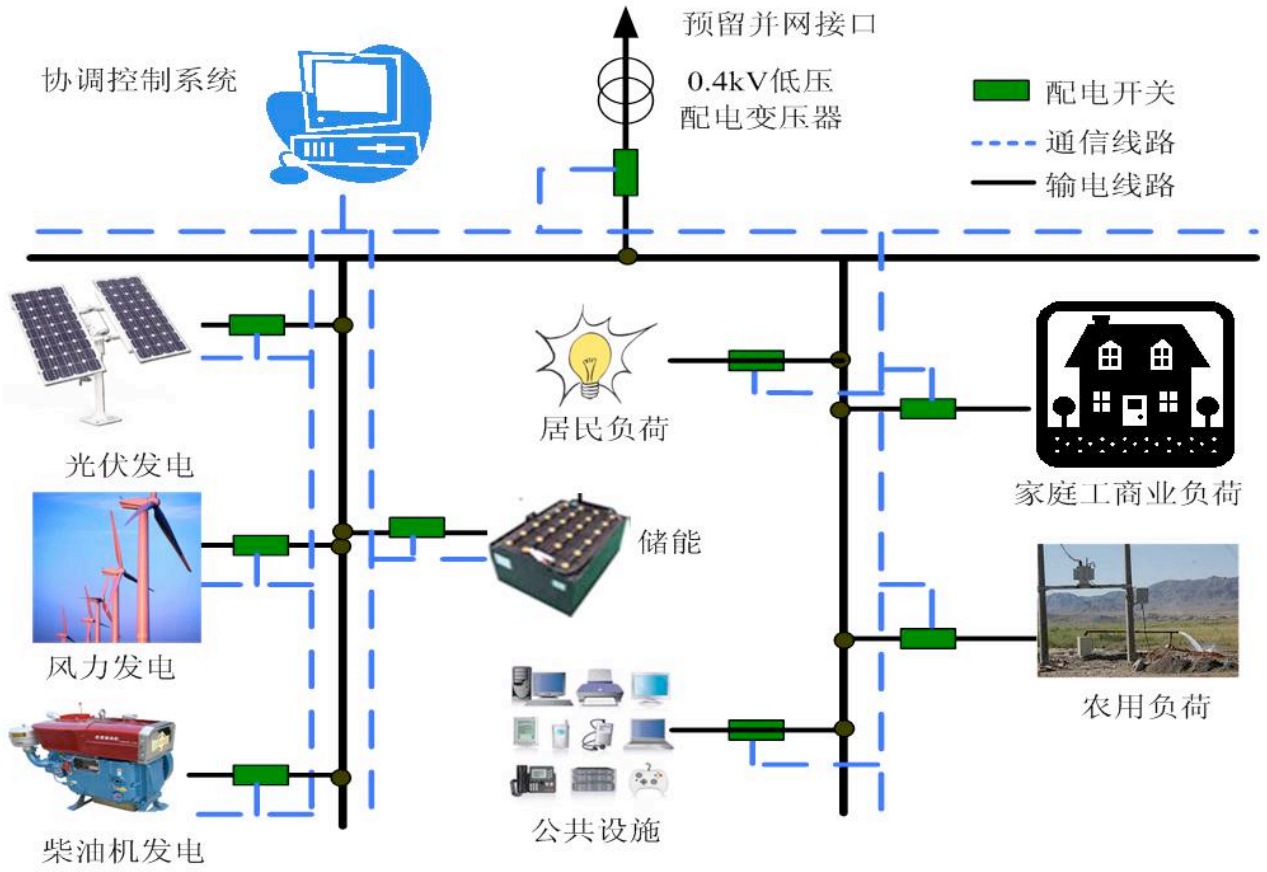
➢ Generation system
- PV+wind+storage+diesel
- PV+storage +diesel
- PV+wind+storage+micro hydro
- PV+storage+micro hydro

➢ Storage system
- Lead acid battery
- Fe battery
- Zinc Bromine battery
- Super capacitor

Typical construction mode

3.Town mode

- PV generation 90kWp
- Wind generation 30kW
- Storage 250kW/800kWh
- Diesel generator100kW



Wind-PV-Diesel-Storage micro-grid

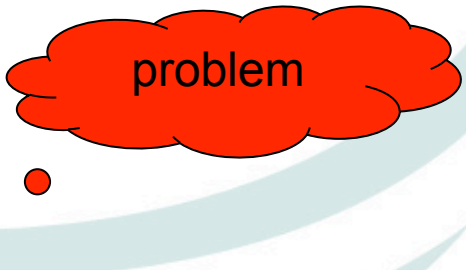
Content

Wind-solar-storage micro grid project in Qinghai

1.Basic information

Off-grid PV generation station re-building project in Yangkang Village, Tianjun County, Haixi City, Qinhai province.

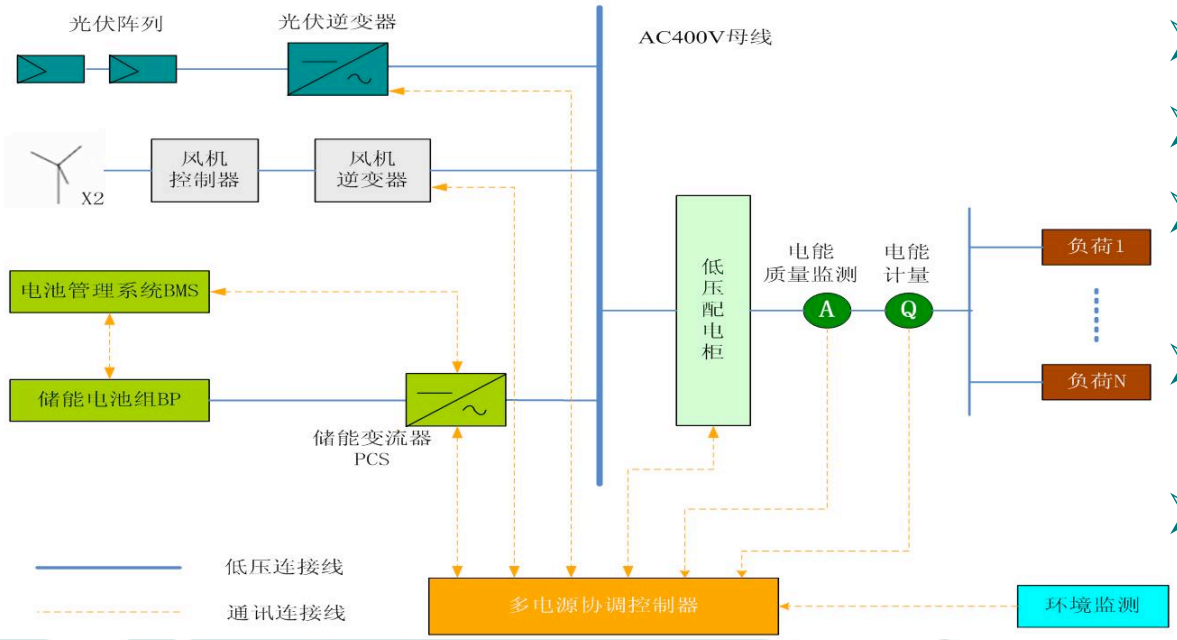
- Original build time: Sep. 2003. cover area: 1250m2 , line length:6km
- Total capacity: PV 30kW, storage: 858kWh
- Off-grid single phase 220V system



- PV cells ageing
- Battery ageing
- Bad repair

Wind-solar-storage micro grid project in Qinghai

2.Rebuilding solution

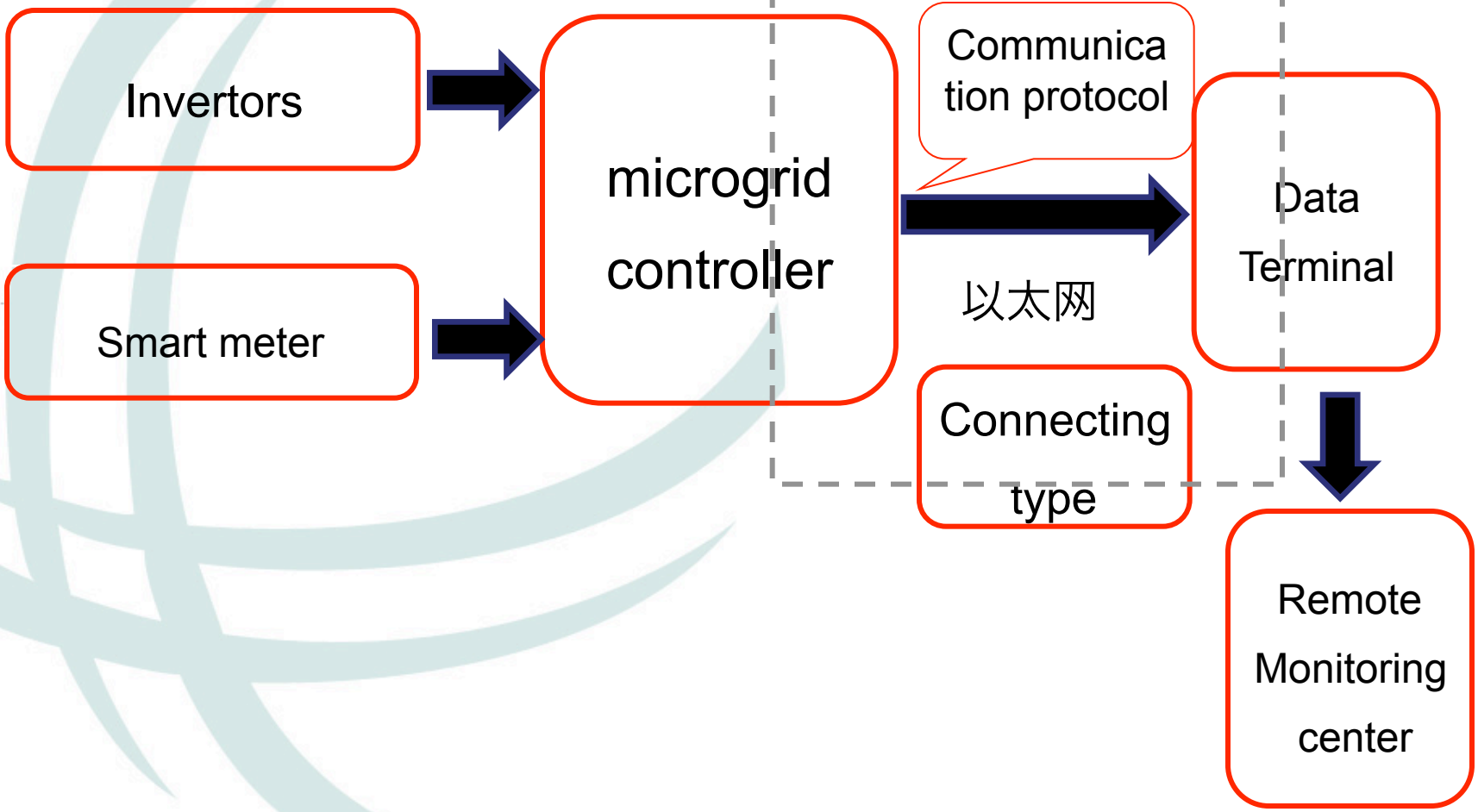


Wind-solar-storage generation system

- 30kWp PV generation
- 20 kW wind generation
- 100kW/864kWh storage system
- Low voltage distribution network
- Electric energy metering system
- Power quality monitoring system
- Microgrid controller

Wind-solar-storage micro grid project in Qinghai

3.Remote monitoring solution



4. Comparison of construction mode

■Before rebuild：

➢PV generation output voltage is single phase 220V. The capability cannot meet the load demand.

➢Only operating in off-grid mode.

➢Simple operation strategy.

➢Operation data cannot be sent to remote monitoring system.

■After rebuild

➢three phases 400V output.

➢off-grid mode and on-grid mode

➢Optimal control could supply power all day.

➢Data could be sent to remote monitoring system in real-time. Realized unattended operation.

Content

Distribution generation/ Micro-grid work

1.Micro grid research projects

NO.	Project name	Sponsored
1	High density multi access points BIPV system and co-ordinary with distribution network technology	863 project SGCC science and technology project
2	Distribution energy and smart micro-grid technology development report	National Energy Administration
3	Distribution generation and micro-grid decision support research	SGCC science and technology project
4	Intermittent renewable energy grid on island operation technology research and demonstration project construction	SGCC science and technology project
5	Research of technology system of micro grid	Technology services project of SGCC
6	Renewable distribution energy terminal supply system technology	Sci-technical support project of Jiangsu province

Distribution generation/ Micro-grid work

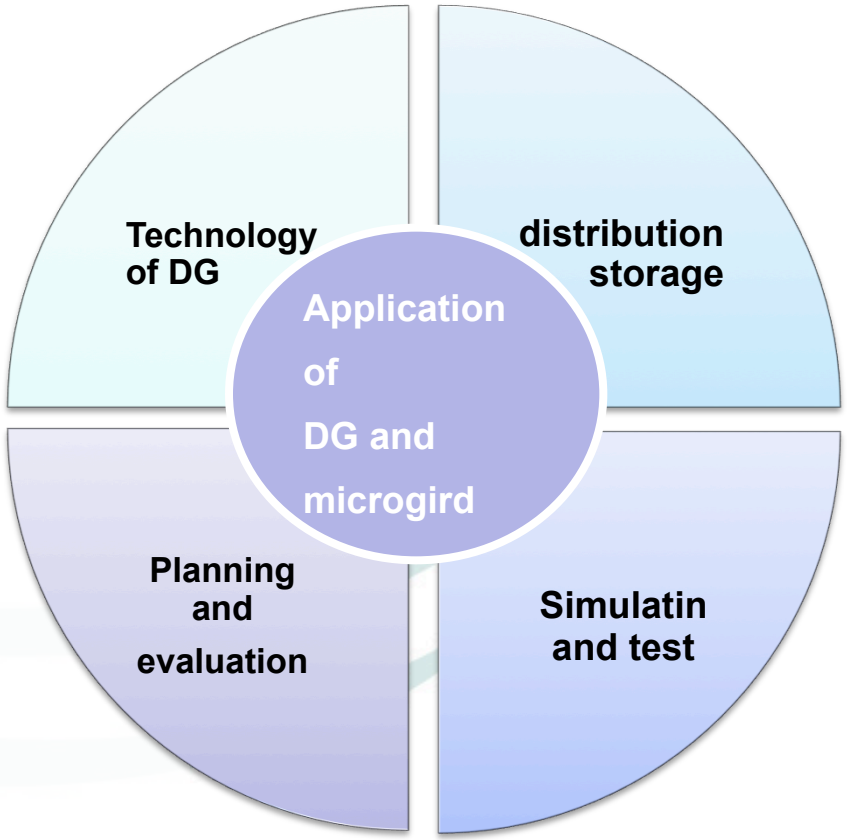
1.Micro grid research project

NO.	Project name	Sponsored
7	Research of solar-storage micro-grid operation & control and protection key technology	Electric Power of Henan
8	Key technology and application of Electricity for All Households in remote area	Electric Power of Xinjiang
9	R&D and demonstration of Rebuilding technology of village micro-grid with solar-storage	Electric Power of Qinghai

2.Research fields of DG and MG

- PV invertor R&D
- Wind power converter R&D

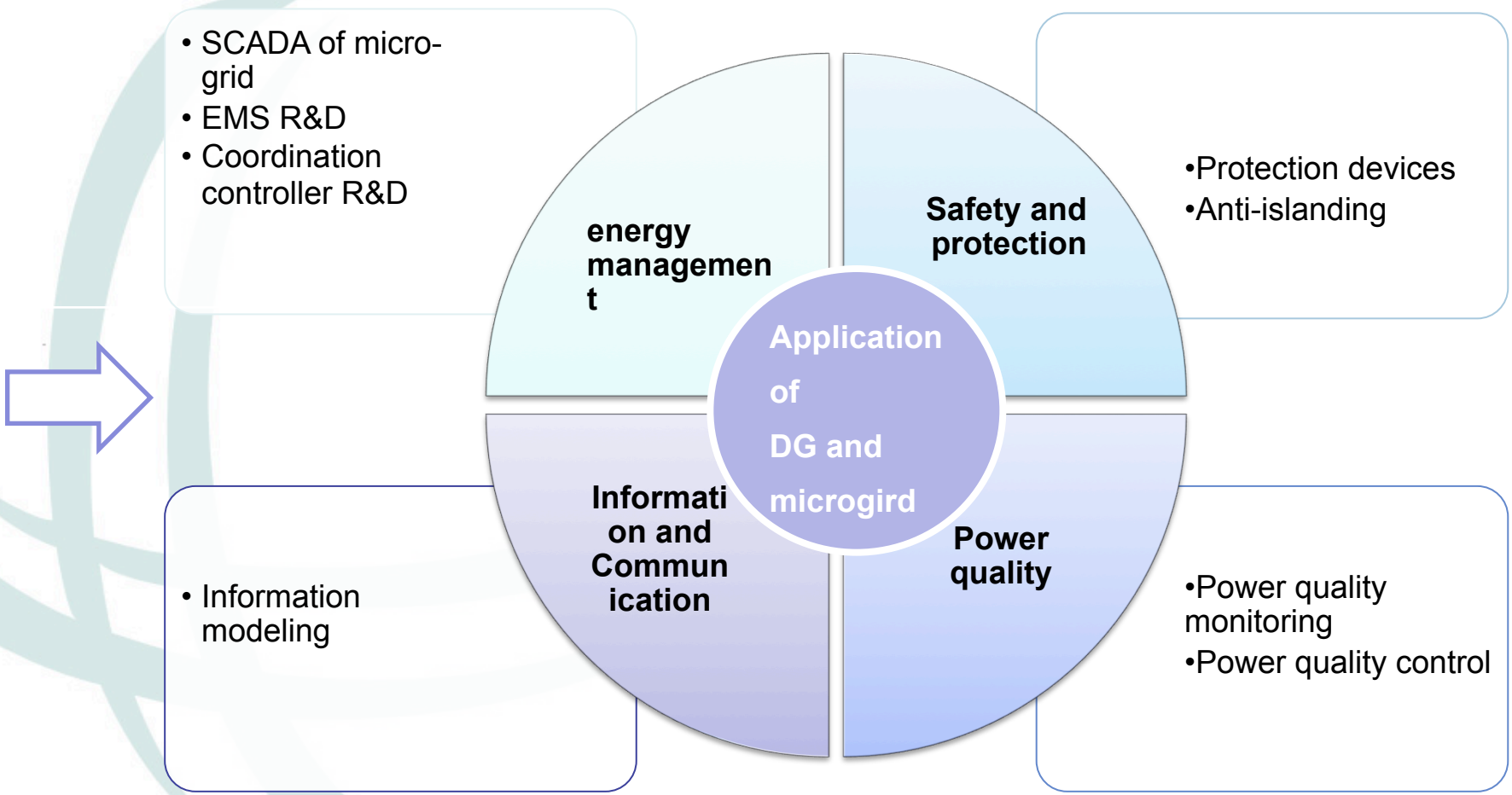
- GAMS modeling and programing technology



•Storage system converters R&D
•Storage monitoring and protection system R&D
•Hybrid storage technology research

- Modeling and simulation by DIgSILENT
- Micro-grid Lab of Nanjing Pukou
- Micro-grid Lab of Zhangbei

2.Research fields of DG and MG



3.Standard drafting

NO.	Standard	Class
1	Design specification of micro-grid connected to grid	GB
2	Operation and control specification of micro-grid connected to distribution network	GB
3	Test requirement of micro-grid connected to distribution network	GB
4	Technical specification of micro-grid connected to power system	GB
5	Specification of verification and acceptance of micro-grid connected to power system	GB

4. Product R&D

- **Devices**

■ Key devices of micro-grid
✓ EMS of micro-gird
✓ Co-ordinary controller
✓ Network protection and grid connection protection

50/100/250/500kW Storage system converters

✓ EMS of micro-gird

✓ Co-ordinary controller

5. Grid connection testing

National Wind Power Integration Research and Test Center(NWIC)

National Wind Power Integration Research and Test Center has been approved by National Energy Administration in Nov. 2009, and officially put into operation In Dec. 2010

The wind power test site of NWIC is the largest wind power test site in the world and also the only test site which has testing capability of low voltage ride though & grid compatibility and research of Wind-PV-Storage combined operation

5. Grid connection testing

National Energy Solar Center(NESC)

National Energy Solar Center has been approved by National Energy Administration in Sep. 2009, and officially put in to operation in Jul. 2010

With the merely PV power station grid-connected ability and dynamic simulation test ability, the NESC has constructed the largest laboratory PV grid-connected inverter testing platform for 1MW inverter; basing on the National Golden Sun Demonstration Project remote data center constructed, NESC could monitor the remote operation data from National Golden Sun Demonstration Project around China

Indoor test facility for Grid-connected PV systems

Mobile test facility for PV stations

6.Experiment platform

✓Solar-storage micro-grid of NESC

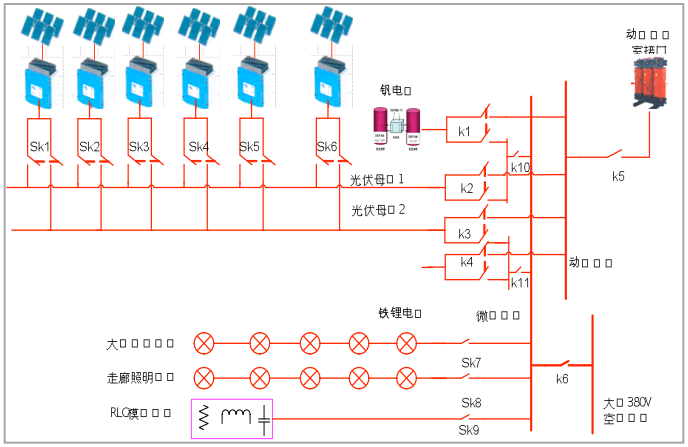
132kWp BIVP in 6 kinds

100kW/60kWh Fe battery system

20kW/40 kWh All vanadium redox flow battery system

40kW load

UI of micro-grid monitoring system



Circuit diagram of MG

6.Experiment platform

✓ Wind-solar-storage micro-grid system in Zhangbei

140kW PV generation、
100kW/4h Li battery system
20kW small wind turbine
100kW/2s super capacitor
60kVA compensator
100kVA load

Wind verification base

Micro-grid devices

7.Engineering application

- ✓ **Industry and mining type:** solar-storage distribution generation in Jiangyin Fangcheng
- ✓ **Experimental type:** Micro-grid experiment platform of Jiangsu EPRI
- ✓ **Island type:** Intermittent renewable energy grid on island in Shandong province
- ✓ **Grid terminal type:** Smart village microgrid demo project in Hebei Chengde
- ✓ **Remote area type:** wind-solar-storage MG in Qinghai
- ✓ **Demonstration project:** wind-solar-storage MG system in Xinjiang EPRI

THANK YOU !